

REGENERATIVE SOLUTIONS FOR LIFTS

SELECTION AND SIZING GUIDE



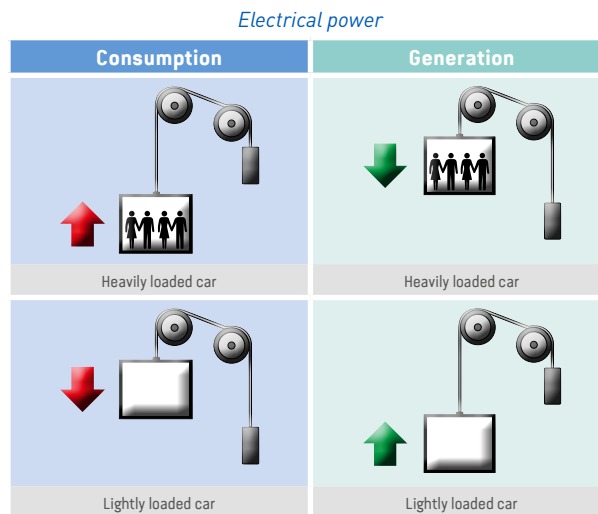
REGENERATION IN LIFTS

AC motors used in traditional drive lifts act as energy generators each time they are "pulled" by the load. This happens when the loaded car moves down or when the empty car moves to higher floors (both normal lift situations). In these conditions, the mechanical system generates potential energy that the electric motor converts into electrical energy.

If the energy generated by the motor is not correctly converted, it may create overvoltages in control systems (typically inverters).

The energy can be converted by passive systems with braking resistors, which convert electrical energy into heat and dissipate it without it being reused, or by regenerative systems that convert electrical energy into clean energy with very low harmonic content and power factor equal to one.

The regenerated energy can be used by other equipment connected to the mains, which saves energy and increases the building's efficiency.



EXTERNAL AND INTEGRATED SOLUTIONS

Regenerative solutions can be achieved with an external Active Front End (AFE) power supply module matched with the ADL300 series, or integrated with the AVRy series in which the same device contains the regenerative module and inverter.

Advantages of the integrated (AVRy) solution

- Compactness
- Inverter Size + Optimized regenerative module

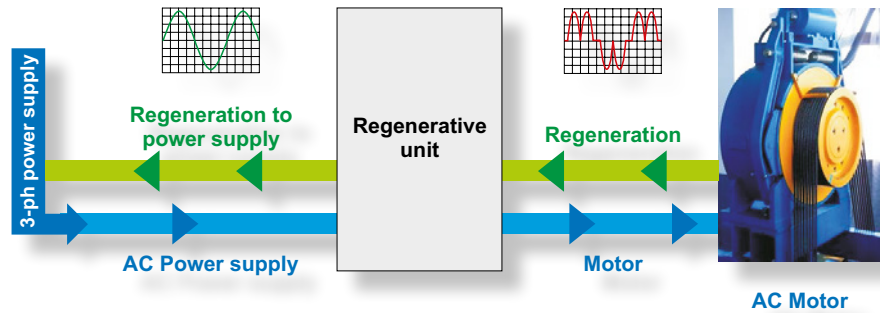
Advantages of the external (AFE200) solution

- Regenerative module shared by Duplex, Triplex, Quadruplex, etc. systems
- Can be installed as add-on to existing inverter
- Control for synchronous and asynchronous motors with extended power range
- Specific certifications available (for example, UL).

ADVANTAGES OF REGENERATION

LOWER ELECTRICAL CONSUMPTION

The regenerative module converts the electrical energy generated by the motor into clean energy, i.e., with no harmonic content (THD <4%), so that it can be reused by all of the other electrical equipment in the building.

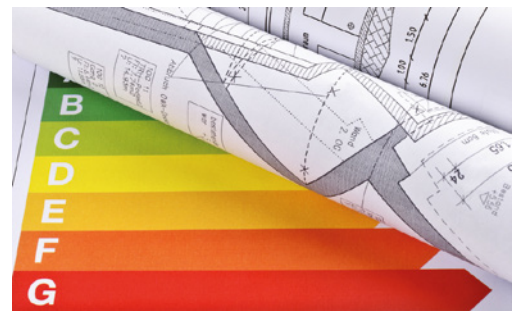


OPTIMIZED MACHINE ROOMS

Regenerative solutions eliminate the need for braking resistors which, if high-power, are often bulky and very heavy, require large spaces for positioning, and are hard to install.

Traditional systems also consume considerable energy to maintain good working temperature: dissipated heat raises the temperature in the machine room, which lowers performance and shortens the life of electrical components.

The temperature has to be controlled by ventilation systems, which increase energy consumption.

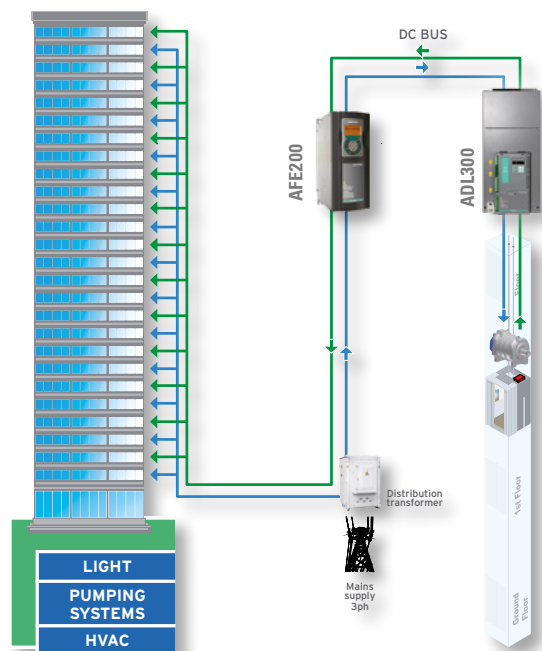


MORE EFFICIENT BUILDINGS

Many factors contribute to improving the energy efficiency of buildings: one of these is energy consumption by electrical equipment.

The majority of such consumption is attributable to air conditioning systems, pump systems, and lifts. If justified by traffic profiles, regenerative solutions can be used to significantly reduce consumption.

In some countries, regenerative solutions also provide large tax reductions.



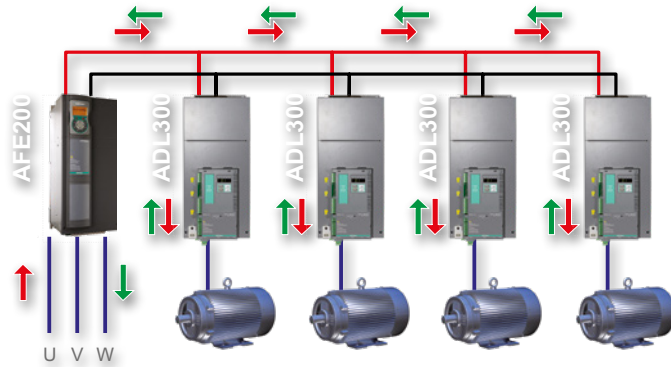
REGENERATION WITH AFE200 EXTERNAL MODULE



SIMPLEX SYSTEMS

Regenerative solutions with Gefran AFE200 external modules can be provided for simplex (i.e., single-car) systems.

The regenerative module must be selected by considering the rated current of the motor and the required overload.



MULTIPLE SYSTEMS

Regenerative solutions with Gefran AFE200 external modules can be provided for multiple systems, i.e., with two or more cars (duplex, triplex, quadruplex, etc.).

In these cases, sizing considers that the regenerative module has to power all of the drives that control the motors. The correct regenerative module must be selected in order to avoid over-sizing and, considering the various overloads, to optimize sizing of the entire system.

SIZING AND SELECTION OF AFE200 REGENERATIVE MODULE

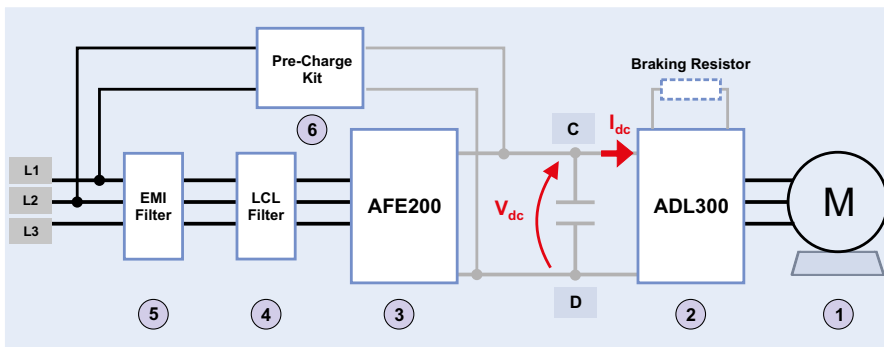


Fig.1: Basic scheme of Simplex regenerative system

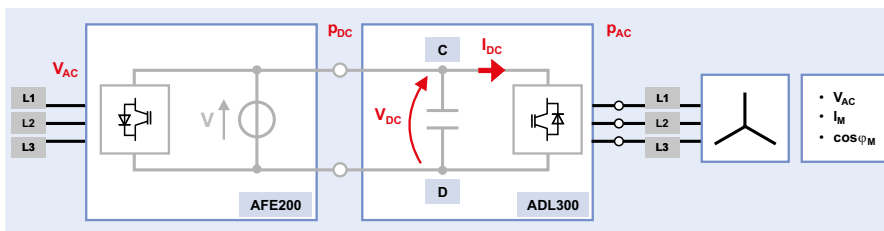


Fig.2: AFE200 regenerative power module

SIZING OF SIMPLEX SYSTEMS

Selection of the regenerative module is based on two main factors: ensuring that the AFE200 regenerative power module can supply adequate current even in overload conditions, and avoiding useless over-sizing. Sizing a solution with an external regenerative module means sizing various parts of the system. The basic scheme of a Simplex regenerative system contains six elements (Fig. 1):

1. Motor. Motor selection depends on system parameters such as capacity, speed, acceleration, car weight, and height. Rated current I_M and power factor $\cos\phi_M$ guide the selection of other regenerative system components.

2. The ADL300 drive is sized in current so that it may deliver the rated current required by the motor. Therefore, the selected size must ensure that the rated output current of the drive is greater than or at least equal to rated current of the motor ($I_D \geq I_M$). The drive is characterized by intrinsic efficiency η_D . The regenerative solution does not need braking resistors; on the other hand, if the system may work with exclusion of the regenerative power supply (for example, in case of breakdown), i.e., working in non-regenerative mode, braking resistors must be provided.

3. The AFE200 regenerative power supply must be able to power the drive and allow it to deliver both rated current and overload current to the motor.

Considering the equivalent electrical circuit (see Fig. 2), input power to the drive PDC must equal output power PAC delivered to the motor as a result of drive efficiency. Current IDC to be delivered by the AFE200 is linked to motor parameters

$$I_{DC} = \frac{\sqrt{3} * V_{AC}}{V_{DC} * \eta_D} * I_M * \cos\phi_M * \frac{Drive\ OVLD}{AFE200\ OVLD}$$

where:

VAC = Mains voltage

IM = Rated current of motor

cosφM = Power factor of motor

ηD = Efficiency of ADL300 drive = 0.97

VDC = Voltage to DC link.

✓ If Vac = 400V → Vdc = 650V

✓ If Vac = 460V → Vdc = 750V

✓ In general, VDC is calculated as VAC multiplied by coefficient 1.625.

Drive OVLD = drive overload

ADL300 sizes 1 – 2 – 3 = 2.0

ADL300 sizes 4 – 5 = 1.8

AFE200 OVLD = AFE200 overload (= 1.5).

Selecting the regenerative unit

The selected AFE200 must ensure that the rated output current of the regenerative power supply In (dc) in heavy duty equals the calculated IDC:

$$I_{N\ DC\ (Heavy\ Duty)} = I_{DC}$$

Example:

400Vac power supply: if calculation gives IDC = 166A



- AFE200-4450-KXX-4 (code S9AF02) :
In (dc) = 85A (NOT OK)
- AFE200-5900-KXX-4 (code S9AF03) :
In (dc) = 171A (OK)

4. LCL filter: this reduces high-frequency current ripples to a minimum to prevent overheating of electronic equipment connected to the mains (see Fig. 3).

Selecting the LCL filter

Selection of the LCL filter is linked to the size of the selected AFE200. The filter must be sized in order to tolerate the level of rated input current IN (ac) of the AFE200 in heavy duty.

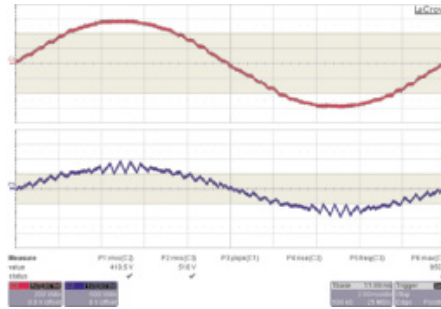


Fig.3: waveform with LCL filter

5. EMI filter: this reduces emissions toward the incoming mains supply.

Selecting the EMI filter

Just like the LCL filter, the EMI filter must be sized in order to tolerate the level of rated input current IN (AC) of the AFE200 in heavy duty.

6. Pre-charge kit: this charges the capacitors on the DC-bus without causing damage by overcurrents.

Selecting the pre-charge kit

The pre-charge kit must be sized based on the energy accumulated in the drive capacitor bank.

See the "Selection Guide Table" below for selection of the LCL filter, EMI filter, and Pre-charge kit.

SELECTION GUIDE TABLE

Pre-Charge Kit	EMI Filter							LCL Filter
	EMI FN3120H-480V-25A (code S7GHE)	EMI FN3120-480-50 (code S7DGV)	EMI FN3120-480-80 (code S73EE)	EMI FN3120-480-230 (code S74EE)	EMI FN3359-480-320 (code S7GOH)	EMI FN3359-480-400 (code S7GHY)	EMI FN3359-480-600 (code S7GHW)	
PRE-CHARGE KIT-AFE-11-4 (code S728286)	AFE200-2110-KXX-4 (code S9AF29)							LCL-Kit-AFE-4-11-HD (code S7LC22)
PRE-CHARGE KIT-AFE-22/45-4 (code S72828)		AFE200-3220-KXX-4 (code S9AF01)						LCL-Kit-AFE-4-22-HD (code S7LC09)
PRE-CHARGE KIT-AFE-90/132-4 (code S728281)			AFE200-4450-KXX-4 (code S9AF02)	AFE200-5900-KXX-4 (code S9AF03)				LCL-Kit-AFE-4-45-HD (code S7LC01)
				AFE200-6130-KXX-4 (code S9AF04)				LCL-Kit-AFE-4-90-HD (code S7LC02)
					AFE200-71600-KXX-4 (code S9AF05)			LCL-Kit-AFE-4-132-LD/160-HD (code S7LC04)
PRE-CHARGE KIT-AFE-160/710-4 (code S728282)						AFE200-72000-KXX-4 (code S9AF06)		LCL-Kit-AFE-4-160-LD/200-HD (code S7LC05)
							AFE200-72500-KXX-4 (code S9AF07)	LCL-Kit-AFE-4-250-HD (code S7LC06)
							AFE200-73150-KXX-4 (code S9AF08)	LCL-Kit-AFE-4-250-LD/315-HD (code S7LC07)
							AFE200-73550-KXX-4 (code S9AF09)	LCL-Kit-AFE-4-315-LD/355-HD (code S7LC08)

Example:

If size calculations indicate the AFE200-5900-KXX-4 (code S9AF03), the following components should be used:

Pre-charge kit: PRE-CHARGE KIT-AFE-90/132-4 (code S728281),

- **LCL filter:** LCL-Kit-AFE-4-90-HD (code S7LC02),
- **EMI filter:** EMI FN3120-480-230 (code S74EE).

SIZING AND SELECTION OF AFE200 REGENERATIVE MODULE

SIZING OF MULTIPLE SYSTEMS

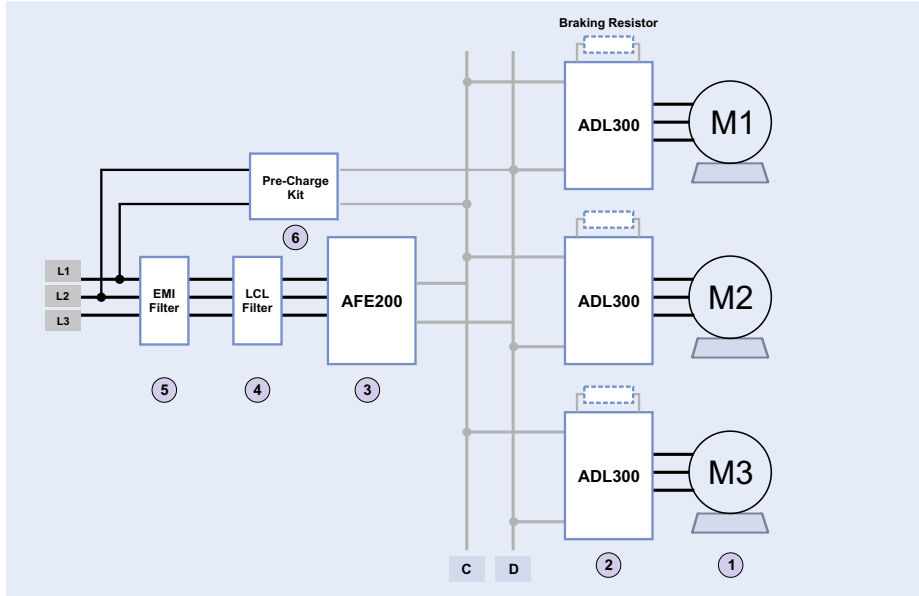


Fig. 4: Basic scheme of multiple regenerative system

A multiple system consists of multiple motors, multiple drives and, typically, only one regenerative power supply (see Fig. 4).

Motors, drives, filters, and pre-charge kit must be selected based on the example of single-car systems.

The regenerative power supply can be sized "in current" by referring to the equivalent electrical circuit (see Fig. 5).

The regenerative power supply will have to power a multi-car system; therefore, it must be able to supply the correct current level to drive the entire multiple system under rated conditions as well as in overload.

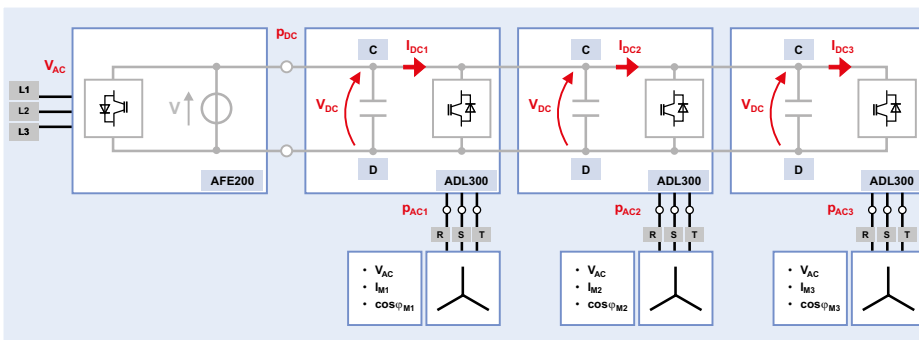


Fig. 5: Equivalent electrical circuit

I_{DC} , the value that guides selection of the AFE200, is calculated as follows (example: use of three cars):

- **Calculating I_{DC} (worst-case situation)**

$$I_{DC} = \frac{\sqrt{3} * V_{AC}}{V_{DC} * \eta_D} * (I_{M1} * \cos\phi_{M1} + I_{M2} * \cos\phi_{M2} + I_{M3} * \cos\phi_{M3}) * \frac{Drive\ OVLD}{AFE200\ OVLD}$$

This is considered the worst case because the AFE200 is sized to power all three motors even under conditions of simultaneous maximum overload.

- **Calculating I_{DC} (normal situation)**

$$I_{DC} = \frac{\sqrt{3} * V_{AC}}{V_{DC} * \eta_D} * (I_{M1} * \cos\phi_{M1} + I_{M2} * \cos\phi_{M2} * \frac{Drive\ OVLD}{AFE200\ OVLD} + I_{M3} * \cos\phi_{M3} * \frac{Drive\ OVLD}{AFE200\ OVLD})$$

This case considers that only two lifts (second and third) can work simultaneously under conditions of maximum overload.

To select the calculation method, consider the system's traffic profile.

Selecting the regenerative module

The selected AFE200 must ensure that the rated output current of the regenerative power supply $I_{N(DC)}$ in heavy duty equals the calculated I_{DC} :

$$I_{N(DC)} (Heavy\ Duty) = I_{DC}$$

REGENERATIVE SOLUTION

Example:

Knowing the supply voltage, rated current of the motors and their respective power factors, you can size the system with the regenerative module shown in figure 6.

Selected ADL300 drives:

- ADL300 (M1): ADL300 18.5 kW
- ADL300 (M2): ADL300 18.5 kW
- ADL300 (M3): ADL300 22 kW

Selected AFE200 regenerative power supply:

- Result of current calculation:
 $I_{dc} = 130A$
- Given that $I_{DC} = 130 A$
 - AFE200-4450-KXX-4 (code S9AF02) :
 $I_N (dc) = 85A$ (NOT OK)
 - AFE200-5900-KXX-4 (code S9AF03) :
 $I_N (dc) = 171A$ (OK)

Filters and pre-charge kit

(from Selection Guide Table)

Selected LCL filter:

- LCL-Kit-AFE-4-90-HD (code S7LC02)

Selected EMI filter:

- EMI FN3120 - 480 - 230 (code S74EE)

Selected pre-charge kit:

- PRE-CHARGE KIT-AFE-90/132-4 (code S728281).

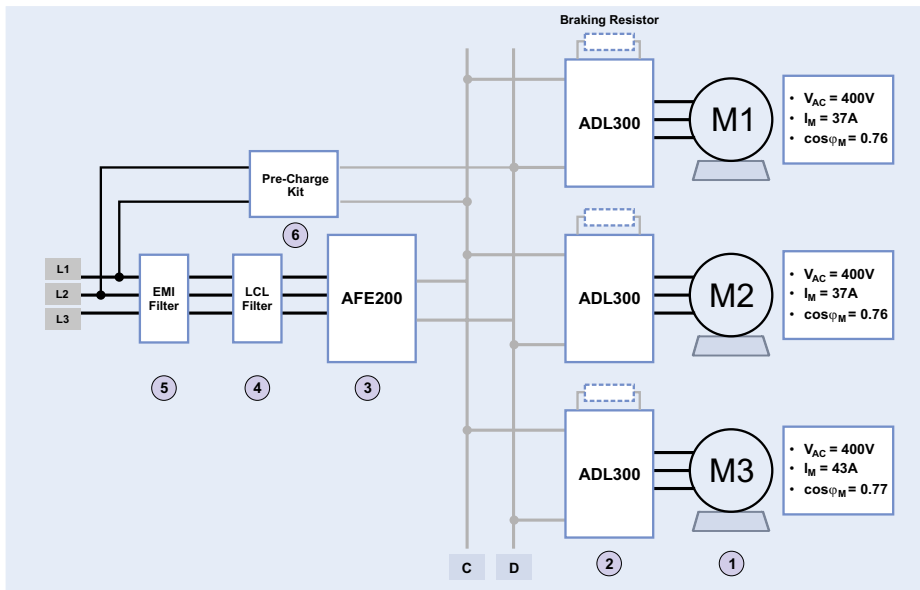


Fig.6: System with regenerative module

SELECTION GUIDE TABLE

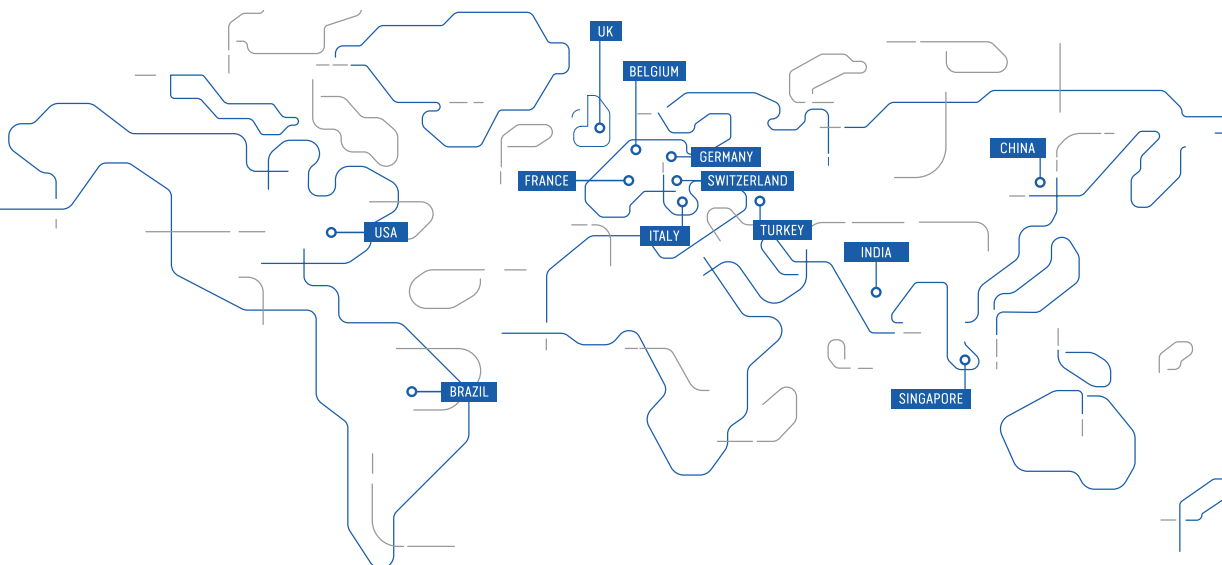
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			AFE200-4450-KXX-4 (code S9AF02)					LCL-Kit-AFE-4-45-HD (code S7LC01)
PRE-CHARGE KIT-AFE-90/132-4 (code S728281)				AFE200-5900-KXX-4 (code S9AF03)				LCL-Kit-AFE-4-90-HD (code S7LC02)
				AFE200-61320-KXX-4 (code S9AF04)				LCL-Kit-AFE-4-132-HD (code S7LC03)
					AFE200-71600-KXX-4 (code S9AF05)			LCL-Kit-AFE-4-132-LD/160-HD (code S7LC04)
						AFE200-72000-KXX-4 (code S9AF06)		LCL-Kit-AFE-4-160-LD/200-HD (code S7LC05)
PRE-CHARGE KIT-AFE-160/710-4 (code S728282)							AFE200-72500-KXX-4 (code S9AF07)	LCL-Kit-AFE-4-250-HD (code S7LC06)
							AFE200-73150-KXX-4 (code S9AF08)	LCL-Kit-AFE-4-250-LD/315-HD (code S7LC07)
							AFE200-73550-KXX-4 (code S9AF09)	LCL-Kit-AFE-4-315-LD/355-HD (code S7LC08)

Example:

If size calculations indicate the AFE200-5900-KXX-4 (code S9AF03), the following components should be used:

Pre-charge kit: PRE-CHARGE KIT-AFE-90/132-4 (code S728281),

- **LCL filter:** LCL-Kit-AFE-4-90-HD (code S7LC02),
- **EMI filter:** EMI FN3120-480-230 (code S74EE).



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